Skeleton of the performance paper

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Mail sent by André (09/21/2016) :

In parallel, we also want to stress our aim to promptly publish papers related to the 3x1x1 construction and results. We are considering at this stage two initial 3x1x1 papers, namely:

- a "technical" paper on the 3x1x1, suitable for NIM or JINST, describing in details the various components of the detectors, and possibly showing a few qualitative results such as cosmic tracks

- a 3x1x1 "performance" paper showing quantitative results obtained from first analyses of the data to be accumulated in the coming months.

→ A preliminary table of content has been prepared, a possible list of measurement has also been defined.

→ This presentation aims to starting the discussion about the data analysis within the SB, to identify people willing to participate to the analysis and to contribute to the writing of the paper.

→ <u>The deadline for the paper submission is Spring 2017</u>

- The paper can be structured into 2 main parts (see also file in attachment):

Performance of the WA105 LAr-proto (3x1x1 m^3) dual-phase liquid argon Time Projection Chamber

Abstract

Text of abstract.....

Keywords: Liquid Argon, dual-phase readout, TPC, LEM, Pure Argon

Contents

1

Description of the detector operative conditions and of its characterization

2

Analysis of muon cosmic data

Before entering in the content of each session it is important to discuss the kind of information that the paper could bring to the reader.

In our view the paper should be for instance be able to provide an answer/feeling to some basic questions:

- How easy is to operate a dual-phase detector and which is its performance?
- How much dependent is the performance on the detector operative conditions ?
- How stable in time is the detector performance?
- How uniform are the performance and operative conditions of the LEM on a large detection surface ?
- How much is the performance dependent on the characteristics of single elements of the readout system and on their overall integration in a large detector ?

(The dual phase technology has already been tested for long time with real data on small prototypes; the goal is now to show how this technology works for charge readout on large surfaces)

Context of 3x1x1

1. **Introduction**

- Future precision measurements in neutrino oscillation and role of LAr TPC
- Principle of operation of Liquid Argon TPC
- Motivation and description of dual-phase readout technology
- Purpose of the 3x1x1 prototype
- Outline of the paper

2. **Experimental Setup**

The 3x1x1 detector description mainly relies on the technical paper. This section recalls just a few crucial aspects. A schematic description of the detector is provided.

Some subsections can be foreseen:

1. Detector main components and monitoring system of operating conditions (slow control measurements, purity monitors)
2. Front-end electronics and DAQ
3. Online storage and computing
4. Cosmic trigger counters

this section has to be fine tuned to avoid duplications with the technical paper

3. Detector commissioning

Description of the operative conditions:

This section aims to describing what has been done (and understood) between the time when the filling started and the time at which stable operative conditions were reached.

- Temperature and pressure evolution as a function of time (temperature gradients in gas and liquid)
- Stability of the liquid/gas surface, presence of bubbles
- Evolution of LAr purity conditions measured with purity monitors, light signals and at a certain point with tracks. Gas phase purity measurements

This first part has to be fine tuned with the contents of the technical paper (section 10). It can however contain some more detailed data than in the technical paper.

Thermodynamical characterization of a range of stable operative conditions of the detector in terms of gas pressure and temperature in the gas.

Data samples collected for a few stable operation points in this range of possible conditions will be then used in the next sections to characterize the LEM performance.

4. Analysis with cosmic muon tracks

4.1. Raw Data description

Description of the trigger used to select cosmic tracks

Description of raw signals: event display pictures, to show "typical" waveforms for muon tracks and noise level

Pedestals: absolute values and difference among channels and their stability in time (correlation with data taking conditions)

Electronics calibration and stability (with preamplifiers and strips charge injection methods)

Signal to noise and its stability with time

4.2. Reconstruction methods

Description of hit and track algorithms. It can be taken from the SPSC report (together with some plots)

Cosmic muons sample: some plots representatives of the muon tracks sample: angular distributions, space distribution, track lengths

4.3. Purity measurements with cosmic tracks

Description of the analysis method used to perform the purity measurement with tracks

Results for both views, comparison with purity monitor results (for purity levels not yet saturating the purity monitor), and evolution of purity during the data taking and correlation with the detector conditions

Uniformity of purity conditions in the active volume

4.4. Charge measurements and gain

After having applied the lifetime corrections: distributions of energy losses per unit of length for cosmic tracks

Description of the method used to evaluate the LEM gain.

For each point in the range of possible stable operative conditions (P,T providing different gas density conditions):

- LEM gain and corresponding spark rate as a function of HV (HV scan)
- Extraction efficiency (should be saturated in all conditions)
- Dependence on liquid level in between the grid and LEM (CRP adjustment)

For the main operative conditions, long term studies with cosmic tracks addressing:

- Gain stability
- Gain uniformity over the 3x1 detection surface
- Anode response as a function of tracks angles with respect to strips pattern
- Correlation of gain with LEM geometry, thickness

4.5. Drift field and space charge effects

Performance studies with different drift fields

Study of space charge effects

Conclusions

- This is a first skeleton, comments and suggestions are welcome

- A subsample of the plots to be included in the paper has already been identified
(cosmic muon sample: angular and space distribution, track lengths,
results from purity measurement on both view and comparison with purity monitor
results, stability in time and space uniformity, charge collected on each view,
gain stability, gain uniformity, gain as a function of HV….)

- Some ideas on the needed statistics already exist for purity and gain measurements with a given accuracy and characterization granularity (see presentations of Slavic and Elisabetta:
https://indico.fnal.gov/getFile.py/access?contribId=3&resId=0&materialId=slides&confId=12481
https://indico.fnal.gov/getFile.py/access?contribId=2&resId=0&materialId=slides&confId=12481);
in order to define more precisely the needed statistics for finer sampling it is necessary to generate some events with the same trigger setup (nearly horizontal tracks selected by the cosmic counters) of the data taking

- We are planning to produce these samples of events, and to make them available to all people, in a public area at CCIN2P3